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REVIEW ARTICLE

Optimizing Cancer Hospital Services in the Era of COVID-19 Pandemic

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ABSTRACT:
The public sector cancer hospitals in Pakistan adopted a resource constrained approach to optimize cancer care delivery to their patients owing to the challenges imposed by COVID-19 pandemic. The cancer patients are immune-deficient, with lymphopenia and neutropenia, either due to the disease process or treatment induced (chemotherapy or radiotherapy). This makes them more vulnerable to all sorts of infections including COVID-19. The smart lockdown approach and transport restrictions enforced by the government remained very effective in controlling the spread of COVID-19, however these brought numerous logistic hurdles both to the cancer patients as well as to the cancer care providers. To prevent overcrowding at the workplace and maintain social distancing, the entire hospital staff was put on staggered duties and patients' appointments were limited and curtailed. A triage was set at hospital entry point where COVID-19 risk scoring was carried out to filter out patients as well as hospital staff suspected of COVID-19. A pass "COVID-19 risk score" of less than 3 was set to allow entry into the hospital. Awareness posters were displayed at hospital entry point, reception, registration, and waiting areas to guide patients and public about COVID-19 and the importance of adopting the preventive measures such as wearing of facemasks, hand sanitation and social distancing. The education and training of hospital staff regarding COVID-19 prevention, infection control, sanitization and disinfection of hospital building and equipment, donning and doffing of personnel protective equipment (PPEs) was carried out side by side. The cancer care services in nuclear medicine department were curtailed. All non-urgent nuclear medicine scans and aerosol generating procedures such as lung ventilation scan, cardiac stress testing and I-131 nuclear medicine therapy were cancelled or delayed. Alternate testing measures and other supportive therapies were prescribed, and patients were counseled to remain in contact with the hospital through teleconsultation. In oncology department all indoor admissions were closed and patients were put on faster "day-care metronomic chemotherapy regimens" or oral maintenance therapies. In radiotherapy department radiotherapy start (RT-Start) prioritization was adopted, after a detailed peer review of each individual patient keeping in mind the urgent or emergent clinical state of the patient without compromising the treatment outcome. During the COVID-19 pandemic, out of the 2091 cancer patients who underwent radiation treatment 27.6% were treated under priority-1 (RT-start within a week), 29.3% were treated under priority-2 (RT-start between 1-4 weeks) and 43.1% were treated under priority-3 (RT-start after 4 weeks). The radiotherapy workload volume was reduced by changing the standard of care radiation treatment protocols to quicker "hypofractionantion protocols" with similar treatment outcome, approved for pandemic situations by national and international radiation oncology societies. We found that this multifaceted optimization applied at various levels in our hospital helped in mitigating COVID-19 spread to the cancer patients along with continued and uninterrupted delivery of services by the hospital, during the era of COVID-19 pandemic.

Keywords: Cancer Hospitals, COVID-10, Pandemic, Optimization, Metronomic Chemotherapy, Radiotherapy, Prioritization, Nuclear Medicine

The public sector cancer hospitals in Pakistan[1] typically are tertiary care centers providing nuclear medicine, oncology, and radiotherapy care to cancer patients under one roof. The patients are referred to these hospitals after the initial surgical excision of the primary tumor and biopsy-proven histopathological diagnosis. This article highlights our experience and challenges in offering nuclear medicine, oncology and radiotherapy services at our hospital in Abbottabad in the backdrop of the coronavirus disease 2019 (COVID-19) pandemic.

The aims and objectives of this review article is to gain an understanding of optimized cancer care delivery to cancer patients at tertiary care, specialized cancer hospitals during the COVID-19 pandemic by sharing our own experience of optimized cancer care services. The COVID-19 pandemic has brought numerous challenges to the healthcare system including cancer care delivery to cancer patients. Optimization of nuclear medicine and oncology services at cancer hospitals in the backdrop of COVID-19 is a developing strategy that needs an in-depth understanding by all the stakeholders including hospital directors, managers, administrators, nuclear physicians, oncologists, radiotherapists, medical physicists, nurses, hospital technicians, and other allied healthcare workers. The scope of this review article is to raise the understanding of cancer care providers about the alterations required in cancer care delivery through sharing our own experience and practices adopted worldwide for this optimization.

Introduction:

The COVID-19 cases were first discovered in December 2019, in Wuhan City of China.[2] Within a short span of a few weeks, this viral infection of the respiratory system rapidly swept across the globe and it was officially declared a pandemic by World Health Organization (WHO) on March 11, 2020.[3] Countries worldwide issued public warnings, travel restrictions, and guidelines for healthcare professionals to contain the spread of COVID-19 and reduce the COVID-19-associated mortality. Also, research and development started for cost-effective COVID-19 screening tests, COVID-19 vaccination[4], and effective anti-viral therapy against the deadly coronavirus.

I. COVID-19 in Pakistan:

The first confirmed cases of COVID-19 in Pakistan were reported on February 26, 2020,[5] and as of March 18, 2020, several cases of COVID-19 were reported inform all four provinces, two autonomous regions, and Islamabad Capital Territory and by June 17, all districts of Pakistan have recorded at least one confirmed case of COVID-19.[6] In Pakistan, we experienced three different waves of COVID-19. The first wave of COVID-19 began in late May 2020, peaked in mid-June, and ended in mid-July 2020. The second wave of COVID-19 began in early November 2020 and peaked in mid-December 2020. The third wave in the country began in mid-March 2021 and peaked at the end of April 2021.[6] Currently, the COVID-19 positivity rate is on the decline.

The government's COVID-19 vaccination campaign and smart lockdown approach have been very successful in combating Pakistan's COVID-19 pandemic situation.

II. Immune Dysfunction in Cancer Patients:

Immune deficiency in cancer patients is a well-documented fact.[7] The cancer cells evolve a wide range of cellular and molecular mechanisms to avoid anticancer immune responses. This increases the susceptibility to infections including COVID-19. Several cohort studies have revealed a higher case fatality rate due to COVID-19 in cancer patients.[8] Several factors affect the immune system of cancer patients making them prone to infections such as the location of primary cancer, stage of cancer, and specific cancer therapies. Lymphopenia is a common finding in many cancer patients and severe lymphopenia has been reported among non-survivors of COVID-19.[9]

a. Chemotherapy Causing Immunodeficiency:

Almost all chemotherapeutic agents such as cyclophosphamide, methotrexate, cisplatin, paclitaxel, and temozolomide cause damage to the bone marrow cells causing neutropenia and lymphopenia.[10] At around 1 – 2 weeks after the completion of each cycle of chemotherapy neutrophil and lymphocyte counts drop to the lowest point[11] and this makes the cancer patients susceptible to infections including COVID-19. Limited data is available to study mortality risk estimates in cancer patients undergoing chemotherapy who become infected with COVID-19. However, for pandemic situations recommendations are there to defer adjuvant chemotherapy in stable cancer patients.

b. Radiation Treatment Causing Immunodeficiency:

Radiation treatment through external beam radiotherapy causes lymphopenia. This is due to the direct toxic effect on lymphocytes irradiated in the

radiation field and has been seen in up to 70% of the cancer patients undergoing external beam radiotherapy.[12] This risk can be reduced by adopting non-standard-of-care techniques of radiotherapy such as hypofractionation.[13] In our hospital we adopted "hypofractionation radiotherapy protocols" in selected patients where radiotherapy could not be deferred or postponed due to the COVID-19 pandemic situation.

III. Optimized Hospital Services during COVID-19 Pandemic:

Like all other hospitals, cancer hospitals switched their operations by adopting all necessary preventive measures and guidelines issued by WHO for COVID-19[14] and its update of June, 1 2020.[15] Based on these guidelines we adopted a strict hospital policy for case finding and contact tracing to prevent COVID-19 infection both in staff and patients. According to a research study published in Italy in March 2020, during the COVID-19 pandemic around 20% of the patients who died of COVID-19 had cancer.[16] In addition, national, regional, and institutional guidelines were developed and adopted against COVID-19 to keep cancer patients and their family members' safe during the COVID-19 pandemic. Institutional guidelines against COVID-19 were developed and adopted by cancer hospitals to ensure continuity of services and to protect the caregivers such as doctors, nurses, and paramedics during the COVID-19 pandemic.

We experienced three waves of COVID-19 each with unique evolving challenges.[17] During the first and second waves of COVID-19, vaccination and COVID PCR testing were not available so we had to rely on personnel protective equipment (PPE), hand sanitation and social distancing. During the third wave, COVID-19 vaccination was mandatory for doctors, para-medical staff and patients in addition to hand sanitation and facemask. Any hospital staff with suspicious respiratory symptoms was isolated and sent for nasopharyngeal swab Reverse Transcription-Polymerase Chain Reaction (RT-PCR) testing for COVID-19.

Our cancer hospital is a public sector hospital located in the North of Pakistan in Khyber Pakhtunkhwa (KPK) province. This is a tertiary care Institute that provides radiation oncology and nuclear medicine services under one roof. We developed a customized institutional policy of delivering cancer care services at our hospital after consulting "COVID-19 Pandemic: Guidelines for Ethical Healthcare Decision-Making in Pakistan" published May 6, 2020, and guidelines issued by World Health Organization (WHO). Following measures were developed adopted for the delivery of optimized cancer care to our patients:

1. General Infection Control Measures based on National COVID-19 Guidelines[18]

a. Measures taken at the Hospital Entry Point / Reception:

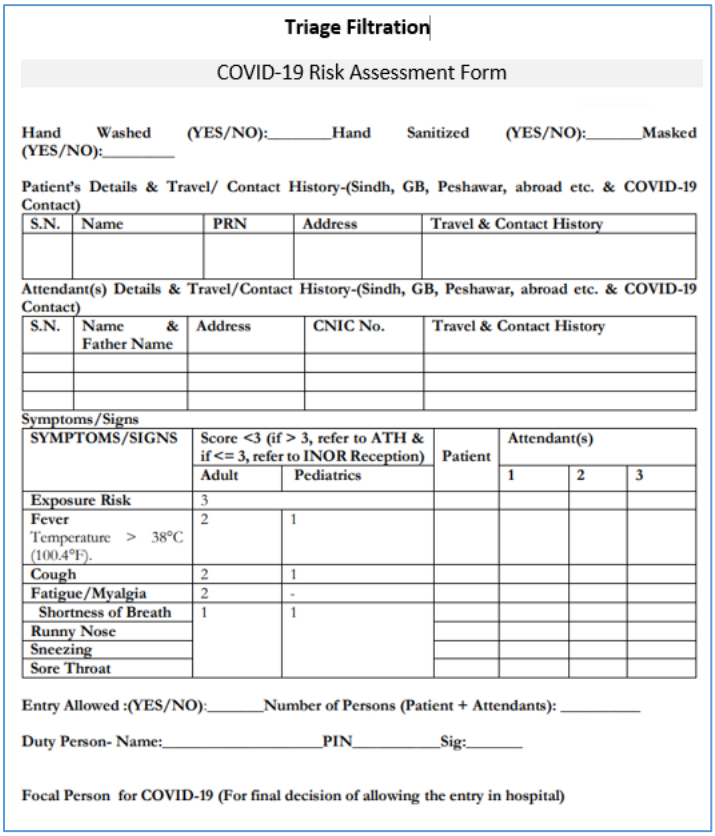
i. Triage and Screening:

Triage means setting up priorities to deliver cancer care by allocating the limited resources; i.e., whom to treat and whom not to treat, when acute care cannot be provided for lack of resources.[19] A triage was setup at the hospital entry gate that comprised of awareness posters about COVID-19; highlighting the importance of social distancing, hand-sanitization and facemasks.

- **Facemasks:** Patient not wearing facemasks were provided facemask at the entry gate before entering the hospital premises.
- **Hand Sanitation:** Hand sanitation with alcohol-based sanitizer solution or gel was performed for each individual intending to visit hospital at hospital entry point.
- **Social distancing:** The patients were educated and guided for social distancing by the hospital staff.

ii. COVID-19 Risk Assessment Scoring:

A COVID-19 screening desk was available at the triage where each patient and accompanying relative underwent quick infrared thermal scanning for fever, and recent travel history to endemic areas of COVID-19 and symptoms of cough and flu were recorded. Any individual with fever, symptoms of cough and flu and recent travel history to COVID-19 endemic areas was not allowed to enter the hospital and were sent to COVID-19 OPD clinic or quarantine center. A hospital staff recorded all these details in a COVID-19 exposure risk assessment form (Figure: 1).



Triage Filtration

COVID-19 Risk Assessment Form

Hand Washed (YES/NO):_____Hand Sanitized (YES/NO):_____Masked (YES/NO):_____

Patient's Details & Travel/ Contact History-(Sindh, GB, Peshawar, abroad etc. & COVID-19 Contact)

S.N.	Name	PRN	Address	Travel & Contact History

Attendant(s) Details & Travel/Contact History-(Sindh, GB, Peshawar, abroad etc. & COVID-19 Contact)

S.N.	Name & Father Name	Address	CNIC No.	Travel & Contact History

Symptoms/Signs

SYMPTOMS/SIGNS	Score <3 (if > 3, refer to ATH & if <= 3, refer to INOR Reception)		Patient	Attendant(s)		
	Adult	Pediatrics		1	2	3
Exposure Risk	3					
Fever Temperature > 38°C (100.4°F).	2	1				
Cough	2	1				
Fatigue/Myalgia	2	-				
Shortness of Breath	1	1				
Runny Nose						
Sneezing						
Sore Throat						

Entry Allowed :(YES/NO):_____Number of Persons (Patient + Attendants): _____

Duty Person- Name:_____PIN_____Sig:_____

Focal Person for COVID-19 (For final decision of allowing the entry in hospital)

Figure: 1 COVID-19 Risk Assessment Form

An individual (patient, staff or visitor) with COVID-19 risk assessment score of more than 3 was not allowed to enter the hospital promises and was immediately referred to a nearby COVID-19 clinic for further evaluation. The patients who could not qualify COVID-19 risk assessment were counseled and advised to get teleconsultation (telemedicine).

iii. **Patients /Visitors Education:**

For the education and awareness of the patients and accompanying family members or visitors, awareness posters, information leaflets and brochures were made available at the reception.

- **COVID-19 Awareness Posters:**

Information posters were displayed at hospital entry gate, triage and initial risk assessment desks to educate patients' visitors and general public.

- **Information Leaflets for COVID-19:**

Information leaflet guiding the general public (patients and visitors) about COVID-19 preventive measures such as social distancing, facemask and hand sanitation were provided.

- **Brochures for Teleconsultation:**

Patients who could not qualify for the initial risk assessment (COVID-19 risk assessment score > 3) were counseled by the hospital staff and an information brochure for teleconsultation was handed over to them to guide them about taking consultation through virtual clinic via "Skype" or "WhatsApp" computer application or dedicated videoconferencing equipment while staying at home.

iv. **Minimize visitors or accompanying relatives:**

The visitors and accompanying relatives were minimized to limit and prevent overcrowding inside the hospital. Adult patients who can manage alone were encouraged and their visitors disallowed while one accompanying relative was allowed with children and old patients who required assistance and support.

b. Measures taken at the registration counter:

Awareness posters about COVID-19 were displayed at the registration area highlighting the general public (patients and accompanying relatives) about the importance of social distancing and wearing facemasks to remain safe from COVID-19 infection. The queue lines at the registration counter were marked (painted) with standing footmarks on the floor, 2 meters apart to

ensure and guide the public (patients and visitors) for social distancing. Alcohol-based hand sanitizers were also made available at the registration counter and patients/visitors were encouraged to use them by hospital staff at the registration counter.

c. Measures taken in the waiting areas:

Awareness posters about COVID-19 were displayed in the waiting rooms of oncology and nuclear medicine clinics, chemotherapy day-care, and radiation treatment areas. To prevent people from sitting closely together and ensure social distancing, alternate sofas or chairs in the waiting rooms were given a cross-sign with masking tape. A hospital staff member was deputed in the waiting area to help guide the patients about social distancing. The patients were advised to wear a facemask while sitting in the waiting rooms. Hand sanitation facility was available in the waiting rooms facilitated by hospital staff.

2. Administrative Measures:

a. Education, Training and Supervision of Hospital Staff regarding COVID-19 Guidelines:

Measures were taken to educate, train and supervise hospital staff. These included:

- **COVID-19 Focal Person:**

A senior hospital physician was designated Focal Person for COVID-19 to supervise that COVID-19 guidelines are truly implemented in letter and spirit.

- **COVID-19 Awareness Lectures:**

COVID-19 awareness lectures were scheduled at regular intervals to educate hospital staff to create awareness about social distancing, the importance of wearing facemasks and hand sanitization.

- **Supervision of the Triage at Hospital Gate:**

The triage that was set the hospital entry was supervised by focal person for COVID-19 to ensure all activities at triage are being carried out as per guidelines.

b. Staff Rotation Schedule:

Overcrowding will hinder social distancing, therefore the entire hospital staff was rotated through staggered duties or paid corona leaves.

- **Staggered duties:**

Occupational Safety and Health Administration (OSHA), USA have issued guidelines[20] for social distancing at work for COVID-19 pandemic. On similar lines but customized as per our needs, we put the entire hospital staff, on staggered duties. Hospital staff more than 55-years of age or those suffering from chronic illnesses such as diabetes, heart disease or renal disease were sent on paid corona-leave. This was done to prevent overcrowding at workplace and to protect more vulnerable segment of the staff form COVID-19 infection.

- **Minimize hospital staff:**

The entire hospital staff was divided into two groups i.e., onsite and offsite groups to work on alternate weeks. Nuclear Medicine scan reports were digitally written by our nuclear medicine physicians while working from home. According to a study on work from home (WFH) during COVID-19 pandemic, the workers' productivity level did not change while working from home.[21]

c. Provision of Personnel Protective Equipment (PPE) Supplies:

A continuous uninterrupted supply of Personnel Protective Equipment (PPE) was ensured. These included surgical facemasks, disposable particulate respirators (N-95 masks), reusable Tyvec or Hazmat suits made of vinyl or non-porous material, or single-use personnel protective suits, and eye protection gear (goggles and face-shield).

d. Practical Training on Donning and Doffing of PPE:

Regular training sessions for hospital doctors, nurses, and staff were arranged regarding the use of PPEs. These included lectures, demonstrations and recorded videos.

The complete procedure of putting on (donning) and putting off (doffing) the PPEs was understood and followed through "videos in clinical medicine".[22] We followed the standard operating procedures (SOPs) and guidelines issued by the Center for Disease Control (CDC) regarding the use of PPEs.

e. Close Liaison with referring physicians:

Focal person COVID-19, doctors and nurses and hospital staff deputed at registration counters kept a close liaison with referring physicians in order to educate them about urgent and non-urgent cases of oncology and nuclear medicine and about cases that can be deferred or delayed.

f. Cleaning and disinfection of entire hospital:

The entire hospital room floors were cleaned and disinfected twice on daily basis; first before the start of the daily work and after the last patient of the day before closing. For cleaning, we used ordinary water and detergent. For disinfection, chemical sprays approved by the United States

Environmental Protection Agency (EPA) effective against SARS-Cov2 such as Sodium Hypochlorite (0.1-0.5%), ethyl alcohol (76.9 – 81.4%), or isopropyl alcohol (70%) can be used.[23] The examination couch, waiting areas, registration counters, equipment rooms, doctors clinics, treatment planning system room, offices of administrative and support staff and washrooms were cleaned and disinfected. In our setting for all practical purposes bleach (sodium hypochlorite) solution was used for disinfection and alcohol-based sprays were avoided because of their flammable nature. Frequent cleaning and disinfection of high-touch surfaces[24] keyboards, mouse, monitors, computers, equipment consoles of gamma cameras, CT simulator, linear accelerator, Co-60 machine and treatment planning system was carried out very carefully using low-level disinfectant.

g. Self-disinfection of hospital staff:

At the end of the day after the last patient before closing, the entire hospital staff was advised to self-disinfect using hand sanitizers or hand washing with soap and water before leaving for home. Those who remained in close contact with patients and used personnel protective suits were advised to take shower after doffing.

h. Hospital Waste disposal:

Single-use PPEs, used gloves and facemasks, surgical gowns etc. were disposed-off in a lid covered waste bin reserved for infected waste and were sent for incineration the same day before closing. Disposal of medical wastes during pandemic situations has been a challenge.[25] We observed up to a three-fold increase in our hospital waste that was sent to the hospital medical waste incinerator for incineration during COVID-19 Pandemic (Figure: 2)

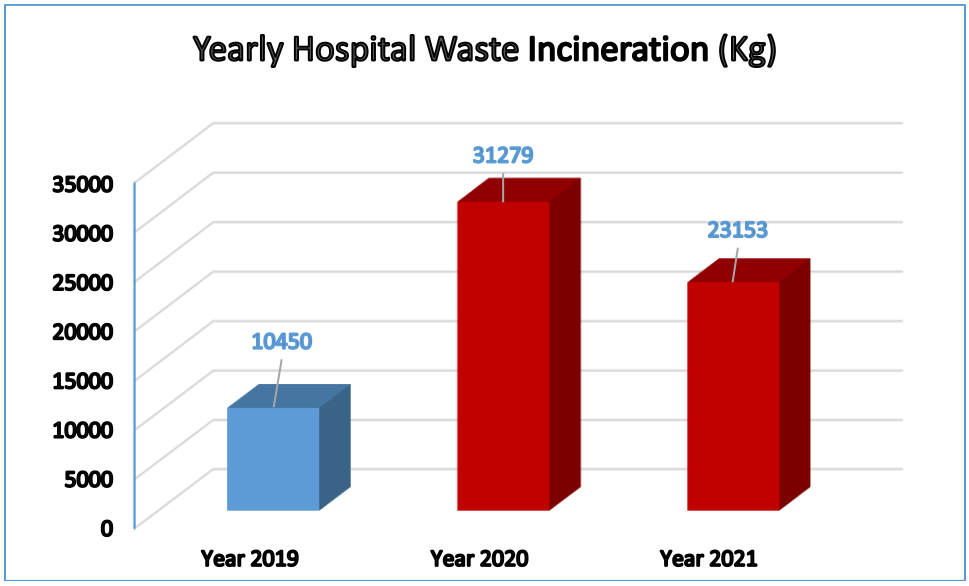


Figure: 2 Yearly Hospital Waste Incineration in kilogram

3. Specific Departmental Measures:

a. Measures taken in Nuclear Medicine Department:

i. Nuclear Medicine Appointments:

All non-urgent, elective nuclear medicine scans and nuclear medicine therapy procedures were deferred or postponed.[24,26] In addition all aerosol-generating procedures such as physical exercise cardiac stress testing in myocardial perfusion scan were not carried out. All myocardial perfusion scans with urgent indications were performed with pharmacological stress using adenosine.[27] During the COVID-19 pandemic it is recommended to postpone lung ventilation scans as well, but at our hospital we did not have this facility. I-131 whole body scans (WBS) in differentiated thyroid cancer also were not performed due to pending I-131 therapy decisions. The table below shows the number of nuclear medicine referrals and tests performed during COVID-19 pandemic (Table: 1).

Table 1: Nuclear Medicine Scan referrals versus those performed during COVID-19 Pandemic

Type of Nuclear Medicine Scan	Year 2020		Year 2021	
	Referrals	Performed	Referrals	Performed
Bone scan	1217	744	1329	986
Thyroid	985	672	1217	921
DTPA (Renal)	543	384	689	561
DMSA (Renal)	43	43	59	59
MPS (Cardiac)	409	143	586	287
HIDA (Hepatobiliary)	23	23	38	38
Meckel's Scan	3	3	5	5
GI Bleed Study	7	7	9	9
Parathyroid	10	10	14	14
Lung Perfusion Scan	16	16	21	21
Total	3256	2045	3967	2901

The following graphs show total nuclear medicine scans performed during the COVID-19 pandemic as a percent of the total referrals (Figure: 3)

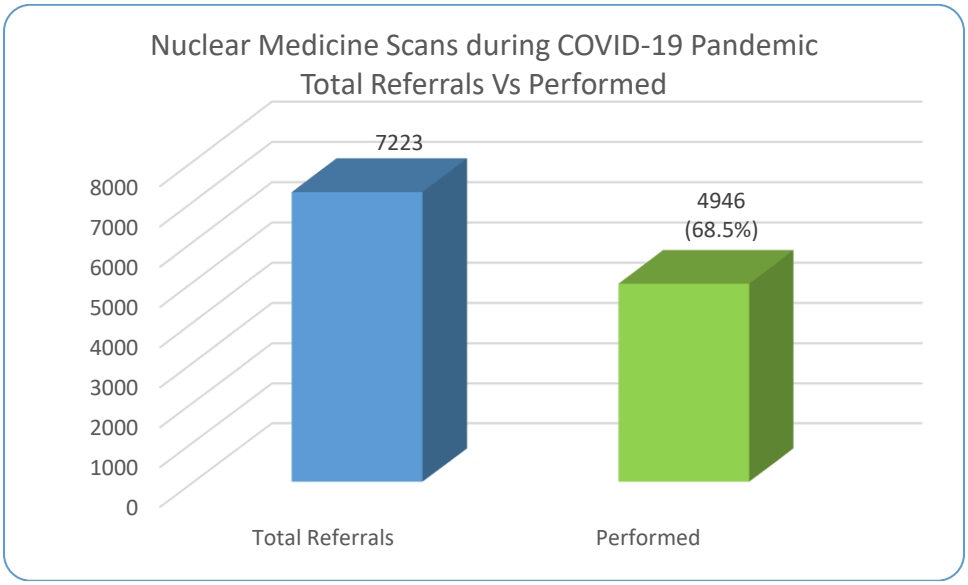


Figure: 3 Total Nuclear Medicine Scans Performed during the COVID-19 Pandemic as a percent of the total referrals

The total referrals for nuclear medicine procedures were reviewed by consultant nuclear medicine physician in consultation with referring clinician and final decision of performing or postponing a nuclear medicine scan was based on risk-benefit ratio keeping in view the COVID-19 pandemic and nuclear medicine scan urgency (Table: 2). The following graph shows the different types of nuclear medicine scans performed as a percent of the total referrals (Figure: 4).

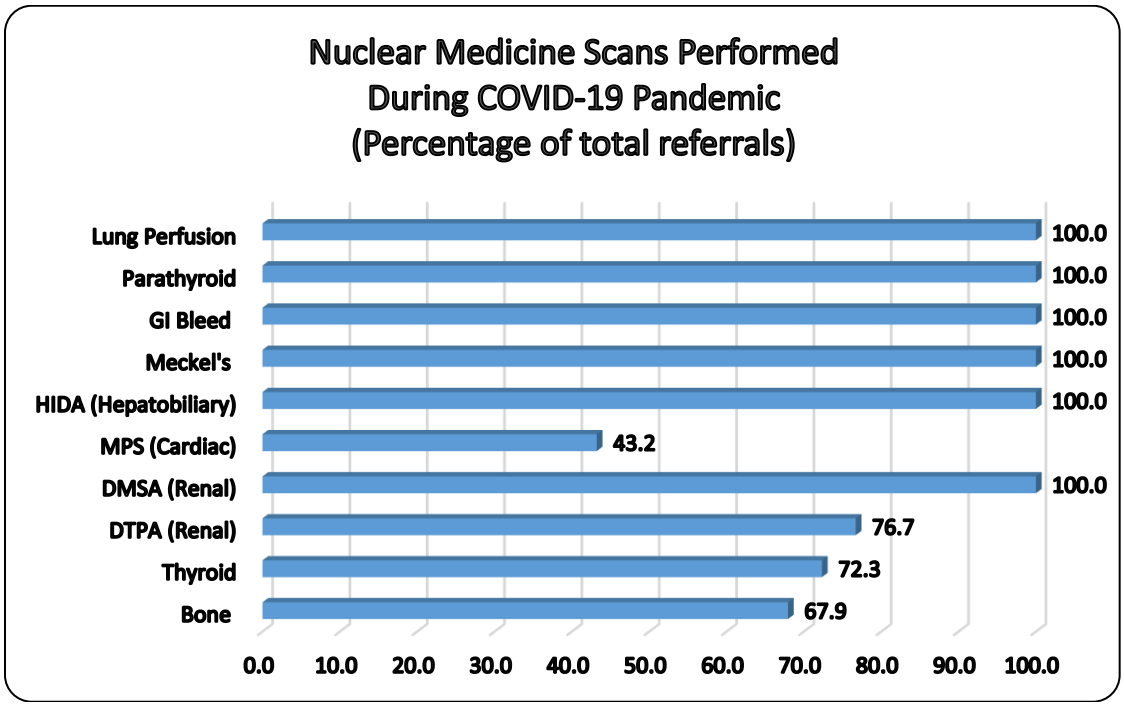


Figure: 4 Different types of Nuclear Medicine Scans Performed during the COVID-19 pandemic as a percent of total referrals

Table: 2 Nuclear Medicine Scans Scheduling on the basis of urgent and non-urgent indications

Type of Scan	Urgent Indications (Scan Performed)	Non-urgent Indications (Scan Postponed)
Bone scan	1. Metastatic Survey 2. Primary bone tumour	1. Osteomyelitis 2. Septic arthritis 3. Metabolic bone disease 4. Orthopedic
Thyroid Scan	1. Patients not on anti-thyroid medications 2. Ectopic thyroid 3. Neonatal hypothyroidism	1. Patients on anti-thyroid medications
DTPA Scan	1. GFR evaluation in patients before the initiation of chemotherapy 2. Renal Transplant Evaluation	1. Obstructive uropathy 2. Split renal function evaluation 3. Follow-up DTPA scan 4. Captopril augmented DTPA study
Myocardial Perfusion Scan (MPS)	1. Recent acute coronary syndrome 2. Patients with new or increasing chest pain (unstable angina) Pharmacological stress with adenosine was used and none of the patients underwent physical exercise testing	1. Patients with stable angina 2. Pre-operative before renal or liver transplant

ii. Nuclear Medicine Clinics:

In Nuclear Medicine clinics a special glass shield was placed all around the doctor's desk and patients were advised to follow COVID-19 protection guidelines such as wearing of facemask and social distancing while visiting doctors in outpatient's clinics. Wearing of facemask, disposable polythene or rubber gloves by doctors attending the patients for consultation was mandatory. Also doctors were instructed to change the gloves after every patient, especially when physical examination such as pre and post-scan assessment for thyroid scan was conducted. Wearing special personnel protective gears, N-95

mask was mandatory during the first wave of COVID-19 when COVID-19 vaccination was not available.

iii. I-131 Nuclear Medicine Therapy Patients:
Radioiodine therapy (I-131 therapy) for differentiated thyroid cancer and benign thyroid disease was deferred. The patients of differentiated thyroid cancer were put on suppressive doses of thyroxine and patients of benign thyroid disease (hyperthyroidism) were put on antithyroid medication. These patients were counseled and were instructed to remain in contact with their treating nuclear medicine physician through teleconsultation (Figure: 5).

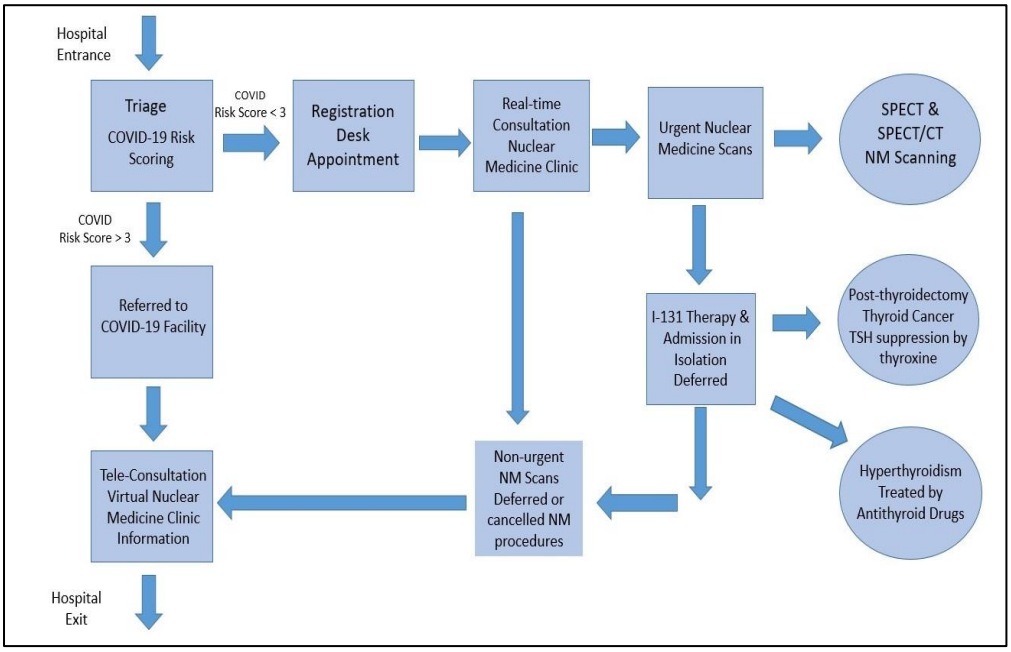


Figure: 5 Nuclear Medicine Workflow Diagram during the COVID-19 Pandemic

iv. Nuclear Medicine Hot Lab:
During COVID-19 pandemic there was a global shortage of hot lab supplies of nuclear medicine such as Tc-99m generators and cold kits due to logistic reasons and lockdown situations.[28] We experienced the same deficient supplies which contributed further to a decline we had in our nuclear medicine services.
Radiopharmacist or nuclear medicine technicians working in the hot-lab responsible for elution of Tc-99m radioisotope from the Generator, preparing, dispensing and injecting radiopharmaceuticals to the patients for nuclear medicine scans, observed complete COVID-19 precautions such as single-use personnel protective equipment and N-95 particulate respirator mask and rubber gloves during the first and second wave of COVID-19. However, during the third wave and thereafter simple surgical facemask, surgical gowns and polythene gloves were used. Hand washing and sanitation was carried out after injecting every patient.

v. Nuclear Medicine Gamma Camera Scanning:
In our hospital, we have two SPECT gamma cameras and one SPECT/CT gamma camera. During the first and second waves of COVID-19 nuclear medicine technicians used single-use personnel protective gowns along with N-95 particulate respirator type of facemask. However subsequently after the national vaccination COVID-19 campaign, ordinary surgical masks and polythene gloves were used without personnel protective gowns. Hand sanitization was mandatory after each radionuclide scanning on a gamma camera. Vaccination against COVID-19 was mandatory both for the hospital staff and patients undergoing nuclear medicine scans.

vi. Digital Nuclear Medicine Scan Reports:
After the nuclear medicine scan was performed, the report was typed by the nuclear medicine physician, and these reports along with scan images were shared digitally with the referring physician or patient via e-mail or "WhatsApp" mobile application. Nuclear medicine physicians were divided into onsite and offsite groups to facilitate

social distancing at the workplace. The offsite group transcribed nuclear medicine reports digitally while working from home. So during the COVID-19 pandemic, we made use of Tele-radiology (Tele-nuclear medicine) in our nuclear medicine department for efficient utilization of our resources.[29] For in-house hospital physicians nuclear medicine reports were shared digitally through Picture Archiving and Communication System (PACS) or hospital management information system (HMIS).

b. Measures taken in Oncology Department:

i. Oncology Clinics:

Same measures were taken in Oncology Outpatients Clinics as in Nuclear Medicine Clinics such as modification of doctor's desks with placement of glass shield, mandatory facemask, social distancing and hand sanitation for patients attending the consultation clinics. Overcrowding and congestion in the clinics was disallowed and physical hospital visits were curtailed to 50% by teleconsultation and postponing non-urgent cancer patients. Follow-up patients with stable disease and no active complaints were asked to consult oncology consultants virtually through teleconsultation (Tele-oncology). In a number of studies Tele-oncology has been found to be very effective in delivering cancer care during the pandemic situation.[30, 31] This is particularly very effective in follow-up cancer patients on oral therapies. An OPD room was specified for teleconsultation where an Oncology Consultant was available virtually during OPD hours via "Skype" or "WhatsApp" computer applications. During the first wave of COVID-19 when COVID-19 PCR testing and COVID-19 vaccination was not available, doctors in oncology OPD clinics used complete personal protective gears and N-95 masks for COVID-19 protection. But subsequently when most of our population was partially or completely vaccinated against COVID-19, reliance was on ordinary single-use surgical facemask.

ii. Oncology Wards:

All indoor admissions in Oncology wards were closed during the first wave of COVID-19 but later on during the second and third wave of COVID-19 when COVID-19 PCR testing, COVID screening tests were available and national vaccination drive started, limited admissions were allowed. For patients with suspicious respiratory symptoms a negative nasopharyngeal swab COVID-19 Reverse Transcript-Polymerase Chain Reaction (RT-PCR) test (within 3-days) or valid COVID-19 vaccination certificate was mandatory for indoor admission in Oncology Wards.[32] During the second wave of COVID-19 when COVID-19 vaccination was partially complete through national COVID-19 vaccination drive, patients admitted in Oncology Wards were managed by doctors, nurses and hospital staff wearing COVID-19 personal protective gears.

iii. Switching from Conventional Chemotherapy to Metronomic Chemotherapy:

Chemotherapy during COVID-19 pandemic was performed by gradually shifting standard of care chemotherapy to Metronomic Chemotherapy (MC). In Metronomic Chemotherapy low doses of chemotherapeutic agents are administered with frequent schedules at close intervals. It is associated with lesser side effects than standard of care chemotherapy.[33] Most of the chemotherapeutic agents were administered orally and that protected our patients from COVID-19 during travel from home to hospital and back. Moreover, it had low toxicity profile as supported by many other research studies.[34] We have analyzed two years of hospital data of patients who underwent chemotherapy during the COVID-19 pandemic from Jan 2020 to Dec 2021 and the results are shown (Table: 3).

Chemotherapeutic cycles that were repeated on three weekly basis were delayed and chemotherapy cycles that involved 24-hour infusion such as 5-Fluorouracil (5-FU) were replaced with capecitabine. Targeted therapies that required I.V infusion were changed to subcutaneous form e.g., Trastuzomab, and Rituximab. In breast cancer patients' weekly chemotherapy (Paclitaxel based) is the standard of care, due to the COVID-19 pandemic it was changed to three weekly regimens.

We found metronomic chemotherapy especially the oral therapies in combination with teleconsultation, in non-critical and stable cancer patients, very effective in optimizing cancer care during the COVID-19 pandemic.

Table: 3 Chemotherapy during the COVID-19 Pandemic

Type of Cancer	**Standard of care Chemotherapy (Used in some patients)**	**n**	**Metronomic Chemotherapy (Used in COVID-19 pandemic in most of the patients)**	**n**
Breast	AC regimen followed by weekly Paclitaxel (16 cycles)	173	AC regimen followed by 3 weekly Paclitaxel (8 cycles) or 6 cycles of TAC regimen	407
Head & Neck	TPF chemotherapy (4 days 24 hr infusion)	31	Gemcitabine, Cisplatin chemotherapy	213
Colorectal	FOLFOX regimen (2 days 24 hr infusion)	12	CapeOX regimen (5FU replaced oral Capecitabine)	154
Stomach	Cisplatin, 5FU (4 days 24 hr infusion or FLOT (1 day 24 hr infusion)	9	CapeOX regimen (5FU replaced oral Capecitabine)	141
Sarcoma	AIM (24 hr infusion of doxorubicin)	5	AIM (bolus doxorubicin given)	93
Urinary Bladder	Gemcitabine Cisplatin for 3 weeks	10	Gemcitabine, Cisplatin for 2-weeks	85
Esophagus	Cisplatin 5FU (4 days 24 hr infusion) or FLOT (1 day 24 hr infusion)	6	CapeOX regimen (5FU replaced oral Capecitabine)	80
	Total	246	Total	1173

AC = Adriamycin, Cyclophosphamide
TAC = Docetexal, Adriamycin, Cyclophosphamide
TPF = Docetexal, Cisplatin, 5-Flourouracil (5-FU)
FOLFOX = 5-FU, Leucovorin, Oxaliplatin
CapeOX = Capecitabine, Oxaliplatin
AIM = Adriamycin, Ifosfamide, Mesna

The graph below (Figure: 6) shows shift from Standard of Care Chemotherapy to Metronomic Chemotherapy

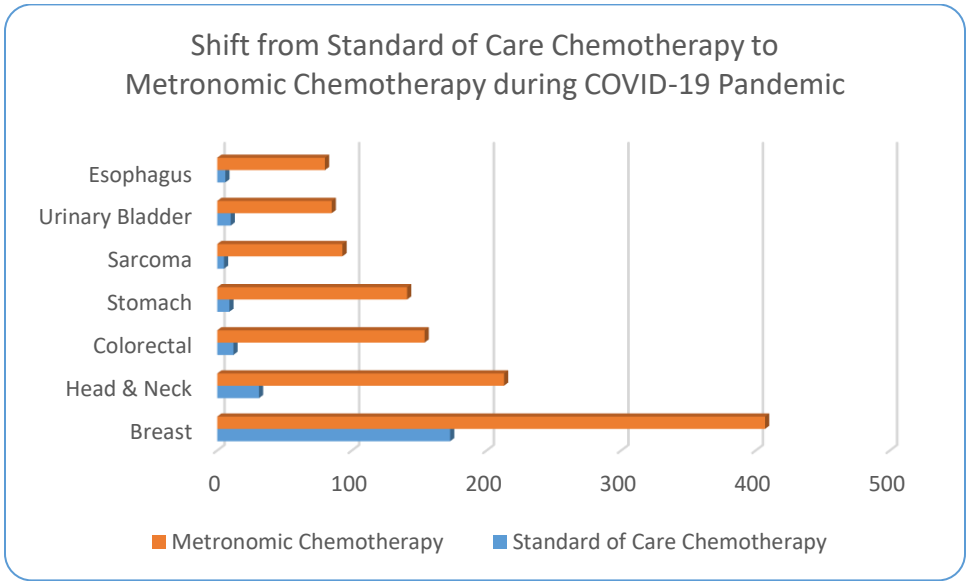


Figure: 6 Metronomic Chemotherapy for different types of cancers during the COVID-19 Pandemic

vi. Change in treatment modality:

In some of our patients we changed the treatment modality keeping in view the patient's access to the hospital due to COVID-19 associated lockdown and logistic restrictions. Since elective surgeries were postponed due to COVID-19 pandemic and only emergency surgeries were being performed, the treatment modality was changed where upfront surgery was standard of care as shown (Table: 4).

Table: 4 Change in Treatment Modality in Different Types of Cancers during the COVID-19 pandemic

Type of Cancer	Standard of Care	n	Change in Treatment Modality	n
Breast	Upfront Surgery	109	Neoadjuvant Chemotherapy	464
Head & Neck	Upfront Surgery	29	Neoadjuvant Chemotherapy	71
Ovary	Upfront Surgery	23	Neoadjuvant Chemotherapy	141
Colorectal	Upfront Surgery	53	Neoadjuvant Chemotherapy	107
Stomach	Neoadjuvant Chemotherapy	100	Upfront Surgery	49
Prostate	Hormonal therapy (Leuprolide)	123	Bilateral Subcapsular Orchiectomy	22
Sarcoma	Upfront Surgery	17	Neoadjuvant Chemotherapy/Radiotherapy	71
Urinary Bladder	Chemoradiotherapy	80	Surgery after Chemotherapy	15
Esophagus	Neoadjuvant Chemoradiotherapy	70	Upfront Surgery	16
		604		956

In case of urinary bladder cancer, the patients who were planned for concurrent chemoradiotherapy, during COVID-19 pandemic situation only chemotherapy was given followed by surgery and radiotherapy was omitted. Similarly for esophageal cancers neoadjuvant chemoradiotherapy was omitted and the patent was sent for upfront surgery and radiotherapy was delayed to Priority-3.

Regarding the cases Head and neck cancer, especially those involving the oral cavity and salivary gland, where upfront surgery is the treatment of choice and was surgery was delayed due to COVID-19 pandemic, chemotherapy upfront was given. Same scenario occurred in the cancers of other region like colorectal.

In case of stomach cancer cases, instead of upfront surgery followed by chemoradiotherapy, due to COVID-19 pandemic treatment modality was changed to upfront chemotherapy followed by surgery. Instead of giving 3-4 cycles before surgery, more than four cycles of chemotherapy were given before surgery due to delays in surgeries caused by COVID-19 pandemic. Other researchers have reported similar experience of changing the treatment modality during COVID-19 pandemic.[35]

The extent of change in the treatment modality in different types of cancers can be well appreciated in the following graph (Figure: 7)

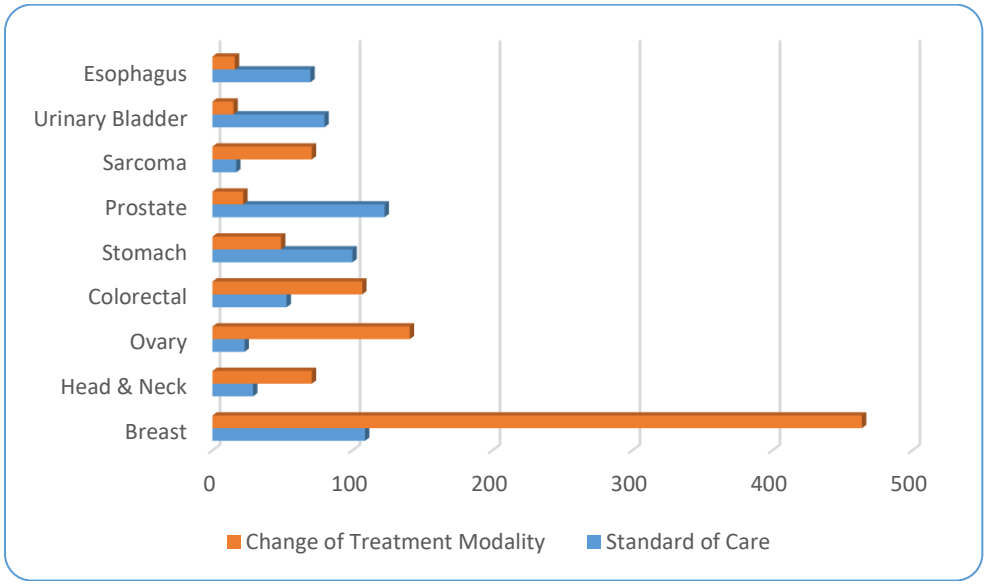


Figure: 7 Extent of change in treatment modality in different types of cancers during the COVID-19 pandemic

c. Measures taken in Radiotherapy Department

During the COVID-19 pandemic our radiotherapy department implemented Institutional COVID-19 infection control guidelines to minimize the risk of COVID-19 infection among cancer patients and caregivers. These measures were adopted at various levels such as simulation, radiotherapy treatment planning and radiotherapy dose delivery through radiotherapy machines namely Co-60 machine and Linear accelerator. At the same time continuity of radiation treatment was ensured by modifying standard of care radiation treatment protocols and delaying or prioritizing non-urgent cases.

Cancer patients undergoing radiation treatment are immunocompromised due to the ongoing disease process. The added bone marrow suppression (lymphopenia and neutropenia) due to previously or concurrently administered chemotherapy makes them prone further to all sorts of infections including COVID-19. In more than 20% of cancer patients with metastatic solid tumors, peripheral lymphopenia (pre-existing or iatrogenic) strongly effects survival.[36] We therefore very carefully optimized radiation treatment of our cancer patients, analyzing the risk-benefit ratio in each individual case. The risks associated with radiation treatment in COVID-19 pandemic could be greater than the risk of omitting or postponing radiation treatment. In addition to the general national guidelines issued by National Command and Operations Center (NCOC) for hospitals, our hospital followed the recommendations of the Pakistan Society of Clinical Oncology (PSCO) and International Oncologic Societies such as ASTRO and ESTRO.[37] During the second and third waves of the COVID-19 pandemic when COVID-19 vaccination was available as per ESTRO guidelines and recommendations all cancer patients for radiation treatment were administered mRNA containing COVID-19 vaccine.[38] These vaccines do not contain any virus, and there is no risk of contracting the infection from them. A general consensus was reached between radiation oncologists, medical oncologists, and surgeons to optimize radiation treatment services at our hospital.

i. Simulation:

Our hospital is equipped with a CT simulator where Simulation of all the patients intended for radiotherapy is carried out. The radiotherapy technicians working in Simulation used PPEs, N-95 mask and single-use surgical gloves during the first and second waves of COVID-19, however later on during the third wave and subsequently, ordinary surgical facemask and single-use polythene gloves were used. Hand sanitization and or hand washing was mandatory after each patient. For simulation we used two teams of radiotherapy technicians per time slot and overlapping between the duty hours was avoided. Between two consecutive simulations, a time slot of 10 minutes was allocated to disinfect the room and equipment.[39] Wearing single-use surgical facemask was also mandatory for each patient. In addition, all the patients booked for simulation were prequalified at hospital entry point by COVID-19 assessment scoring (during first and second wave of the COVID-19 pandemic) and possession of valid COVID-19 vaccination certificate (during the third wave of the COVID-19 pandemic).

ii. Radiotherapy Treatment Planning:

Radiation treatment planning, contouring (delineation) was conducted jointly by a medical physicist and a consultant radiation oncologist on dedicated treatment planning system (TPS) connected with Linear Accelerator or Cobalt-60 machine. As direct contact with patients was not required in treatment planning room, ordinary surgical facemasks, social distancing and frequent hand sanitization was employed while treatment planning. Two groups (onsite and offsite groups) of radiation oncologists and medical physicists performed their tasks in alternate weeks. Between shifts low level disinfectant was used to disinfect high-touch surfaces such as TPS consoles, computer keyboards and mouse etc.[24]

iii. Radiotherapy Dose Delivery:

For radiotherapy dose delivery on linear accelerator or Co-60 machine, our radiotherapy technicians used personnel protective equipment such as single-use personnel protective gowns along with N-95 particulate respirator type of facemask and single-use rubber gloves during the first and second wave of COVID-19 and during the third wave and subsequently used ordinary surgical facemask, single use-polythene gloves, when most of our population was vaccinated. Frequent hand washing and sanitization was performed after each patient.

Radiation treatment is the mainstay of cancer treatment in several types of malignant tumors. It has been estimated that 50% of cancers need radiotherapy for curative or palliative intent.[40] Whether used in neoadjuvant settings before or as adjuvant therapy after surgery radiation treatment improves the overall survival of the patient. When given with palliative intent for the control of pain or

cord compression due to metastatic disease it improves the overall quality of life of the patient.

At our hospital radiation treatment comprised of external beam radiotherapy (EBRT) administered through linear accelerator (LINAC) or Co-60 teletherapy unit. Since these machines are installed in underground bunkers (basements) i.e., less ventilated and closed areas; this could represent potential sites of COVID-19 exposure to patients, doctors and other caregivers working in this closed environment.

During the second and third waves of the COVID-19 pandemic when vaccination against COVID-19 and PCR testing for COVID-19 was available, the entire hospital staff including doctors and nurses were vaccinated against COVID-19. In addition COVID-19 vaccination was mandatory for all the patients who were admitted for radiotherapy or chemotherapy in the day-care. In patient suspected of COVID-19 due to suspicious respiratory symptoms or fever a negative PCR test for COVID-19 (performed within 3-days) was a mandatory requirement for day-care radiation therapy. Following non-standard-of-care radiation treatment protocols were adopted at our hospital:

- Hypofractionation
- Prioritization and Delayed Radiation Treatment Start

Hypofractionation:

At our hospital we used hypofractionation protocols to address to the challenges imposed on radiation treatment during COVID-19 pandemic. Cases that could not be deferred or delayed were treated by this technique. According to several studies[41] standard of care radiation treatment protocols can be altered and deviation such as hypofractionation can be considered in pandemic situations. Various international oncology scientific societies such as ASTRO and ESTRO and Pakistan Society of Clinical Oncology (PSCO) have further supported these pandemic associated recommendations.[42,43]

Hypofractionation radiotherapy is a quicker method that allows radiation dose delivery in fewer number of fractions. This approach is more suitable in pandemic situations where a reduction in radiotherapy burden is required without compromising the outcome. In multiple trials it has been found that hypofractionation radiation treatment protocols have similar recurrence rates as standard radiation treatment protocols.

Our radiation oncologists had close liaison with radiation oncologists from other hospitals though national and international oncology scientific societies. After thorough deliberations, Institutional protocols for hypofractionation were developed and used in our patients. The table below (Table: 5) shows a comparison of standard of care radiation treatment protocol and hypofractionation radiation treatment protocol that was used in different types of cancers at our center:

Table 5: Standard of Care RT versus Hypofractionation RT

Type of Cancer	Standard of Care	Hypofractionation
Breast	50 Gy in 25 fractions	40 Gy in 15 fractions
Head and Neck	70 Gy in 35 fractions	20 Gy in 5 fractions
Colorectal	50 Gy in 28 fractions	25 Gy in 5 fractions
Brain	54-60 Gy in 30 fractions	40 Gy in 15 fractions
Skin Cancers	66 Gy in 33 fractions	55 Gy in 20 fractions
Prostate	70-80 Gy in 35-40 fractions	60 Gy in 20 fractions
Bronchus and Lung	60 Gy in 33 fractions	30 Gy in 10 fractions
Diffuse NHL	40 Gy in 20 fractions	30 Gy in 15 fractions
Other connective tissue / soft tissue cancer	60-70 Gy in 30-35 fractions	57.5 Gy in 25 fractions

Prioritization and Delayed Radiation Treatment Start:

Radiation treatment (radiotherapy) is the mainstay of oncology services offered to cancer patients at our hospital. Many researchers have highlighted the importance of deferring non-urgent cases and prioritization in radiation treatment start (RT-start) during COVID-19 pandemic to de-escalate the patient burden for radiation treatment.[44,45]

The cancer patients who were to be treated with radiotherapy were peer-reviewed (Fig: 8) by our radiation oncology consultants in daily morning meetings and weekly multidisciplinary meetings with consultants of other hospitals.

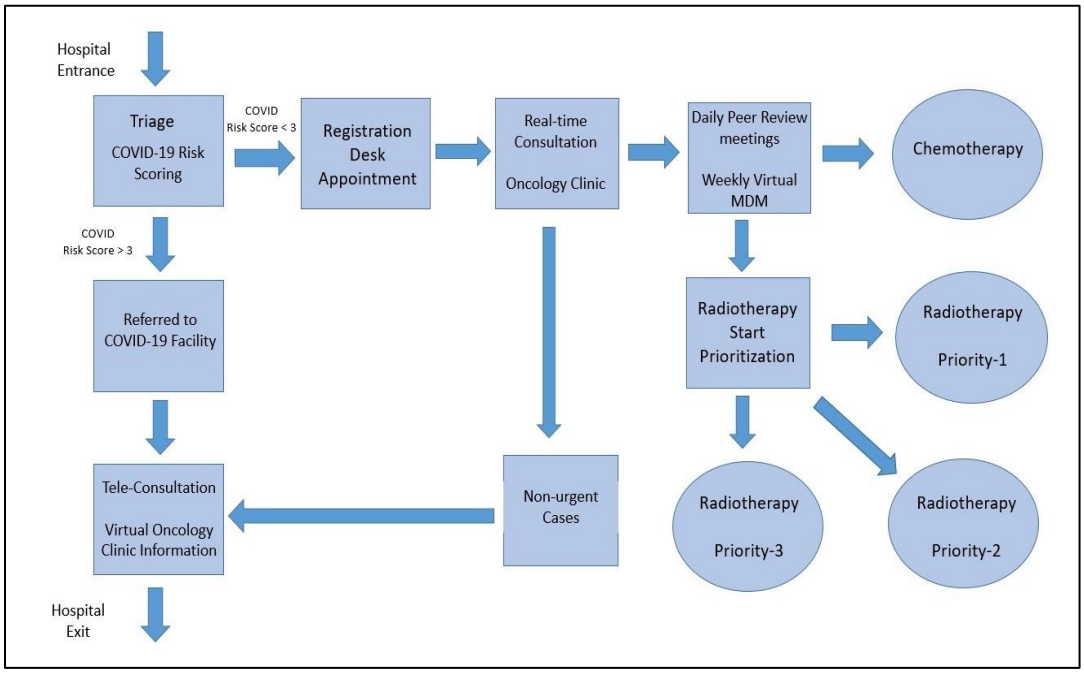


Figure: 8 Oncology and Radiotherapy Workflow Diagram during the COVID-19 Pandemic

Due to COVID-19 pandemic situation these meetings were virtual through videoconferencing instead of real or physical. Around ten senior radiation oncologists, and fifteen other senior consultant physicians from other disciplines met virtually in these meetings. After the decision for radiotherapy was finalized these patients were booked for treatment planning on CT simulation. For CT simulation medical doctors and medical physicists sat together to work-out a customized radiation treatment plan for each individual patient. Due to COVID-19 pandemic situation appropriate, prioritization and deviation from standard of care radiation treatment protocol was taken into account for each individual patient; keeping in view the government smart lockdown restrictions and prevention of COVID-19 infection guidelines.

Patient Priority Listing:

Due to the COVID-19 pandemic situation, radiation treatment starts were staggered by dividing the patient flux into three broad categories through priority listing as shown in the table (Table: 6) below:

Table: 6 Priority listing criteria for upfront radiotherapy

Priority type	Criteria
Priority-1	RT-start within one week (Immediate)
Priority-2	RT-start between 1-4 weeks (Moderate delay)
Priority-3	RT-start after 4 weeks (Extended delay)

Key: RT = Radiation Treatment

Each individual patient was prioritized for radiotherapy keeping in mind that the delay in radiation treatment start will not affect the outcome. Radiotherapy start (RT-start) decisions based on priority listing were communicated to the patients; reassurance and counselling was done side by side by our doctors, nurses and medical physicists to alleviate patients' apprehension of delaying the treatment in priority-2 and 3 cases. It was made certain that all the cancer patients have their priority list assigned before they present to medical physicist for simulation and treatment planning.

During the COVID-19 pandemic era a total of 2091 patients (diagnosed with various types of cancers) underwent radiation treatment at our hospital from Feb 2020 to Dec 2021. These included a mix of radiation treatment cases with curative and palliative intent, as well as patients with neo-adjuvant and adjuvant settings. To stagger the work load owing to COVID-19 these patients were prioritized for radiation start. A break-up of patients on the basis of type of cancer and radiotherapy prioritization type is as follows (Table: 7):

Table: 7 Type of Cancer and Radiotherapy Prioritization

Type of Cancer	Patients (n)	Priority-1	Priority-2	Priority-3
Breast	573	186 (32.5%)	204 (35.6%)	183 (31.9%)
Head and Neck	230	60 (26.1%)	62 (27.0%)	108 (47.0%)
Colorectal	160	22 (13.8%)	73 (45.6%)	65 (40.6%)
Brain	157	27 (17.2%)	29 (18.5%)	101 (64.3%)
Stomach	149	23 (15.4%)	39 (26.2%)	87 (58.4%)
Skin	147	89 (60.5%)	34 (23.1%)	24 (16.3%)
Prostate	145	7 (4.8%)	17 (11.7%)	121 (83.4%)
Bronchus and Lung	138	5 (3.6%)	30 (21.7%)	103 (74.6%)
Diffuse NHL	113	52 (46.0%)	33 (29.2%)	28 (24.8%)
Other connective tissue / soft tissue	98	39 (39.8%)	28 (28.6%)	31 (31.6%)
Urinary Bladder	95	53 (55.8%)	20 (21.1%)	22 (23.2%)
Esophagus	86	14 (16.3%)	43 (50.0%)	29 (33.7%)
Total	2091	577 (27.6%)	612 (29.3%)	902 (43.1%)

As a general rule patients in stage 1 and 2 diseases were assigned priority-1 or 2, while stage 3 and 4 patients or patients with stable disease were assigned priority-3. In addition, patients who needed urgent attention due to advanced metastatic disease-causing severe pain, cord compression, superior vena cava obstruction were assigned priority-1.

Out of the total 2091 patients who underwent radiation treatment, 577 patients (27.6%) were treated under priority-1, 612 patients (29.3%) were treated under priority-2 and 902 (43.1%) patients were treated under priority-3 as shown (Figure: 9).

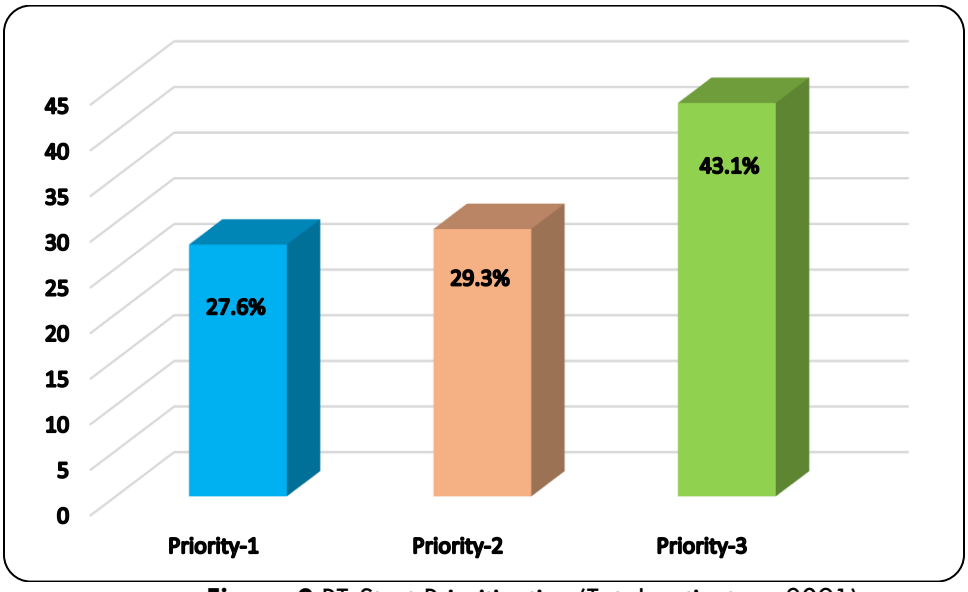


Figure: 9 RT-Start Prioritization (Total patients n=2091)

Percentage RT-Start prioritization was also determined and results are shown (Figure: 10)

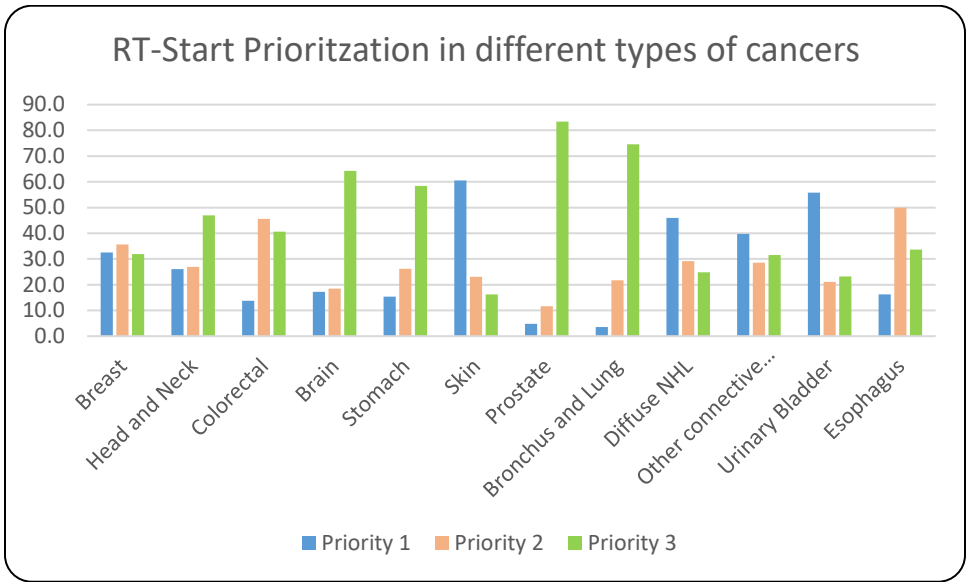


Figure: 10 Percentage RT-Start Prioritization in different types of cancers

Discussion:

COVID-19 pandemic situation has brought significant challenges to the healthcare systems across the world including hospitals dedicated for cancer care. The public sector cancer hospitals of Pakistan successfully adopted to these challenges by optimizing their cancer care delivery. During COVID-19 pandemic our hospital ensured the continuity of nuclear medicine, oncology and radiotherapy services through multistep optimization such as prevention of infection, disinfection and sanitization, triage, prioritization and modification in the standard of care diagnostic and treatment protocols with no adverse outcome on patient management. While making these decisions our nuclear medicine, oncology and radiotherapy consultants made use of telemedicine, videoconferencing, and peer review meetings. Adherence to the advisories and cancer treatment guidelines issued by National[46] and International Oncological Societies for COVID-19 pandemic, was kept for each individual patient. Renowned international oncology societies like ESTRO[47] (European Society of Therapeutic Radiation Oncology), ASTRO[47] (American Society of Therapeutic Radiation Oncology), and ASCO (American Society of Clinical Oncology) issued advisories and treatment guidelines to treat cancer patients during COVID-19 pandemic. These guidelines were developed after mutual consensus by renowned experts in the field of oncology all over the world and were adopted in many countries across the globe. We took help from these guidelines and customized these to develop our National and Institutional guidelines.

The residence time of cancer patients in the hospital was shortened by adopting short and quick day-care protocols in chemotherapy and radiotherapy. Awareness, education and training of cancer care givers (doctors and hospital staff) for COVID-19 prevention and infection control as well as counseling and motivation of cancer patients was carried out side by side to deal with the added psychological stress such as fear and anxiety of COVID-19.

In nuclear medicine department we adopted a multifaceted approach starting from nuclear medicine scan scheduling to nuclear medicine scan reporting as emphasized by Internal Atomic Energy Agency (IAEA) Guidelines and as practiced and advised by renowned international researchers in the field of Nuclear Medicine.[48] Our nuclear medicine consultants kept a close liaison with referring clinicians to decide nuclear medicine studies that can be performed or postponed. All non-urgent nuclear medicine scans and aerosol generating procedures were postponed. The cardiac stress testing for myocardial perfusion studies was changed from physical exercise to pharmacological stress testing with Adenosine. We did not perform exercise stress test for myocardial perfusion scan due to droplet contamination associated with hyperventilation of physical exercise stress testing.[49] In patients with prior history of known asthma where adenosine was contraindicated, stress was performed with dobutamine. All bone scans except those for oncologic indications were postponed, such as bone scans for bone inflammation, metabolic bone disease and those for orthopedic indications. All follow-up DTPA and DMSA renal scans were

postponed. These patients were referred for renal ultrasound for follow-up evaluation. Nuclear medicine therapies with I-131 were also postponed or delayed because the supply of radioiodine for therapy was also affected due to the closure of reactor operations.

In oncology department, cancer patients undergoing chemotherapy were shifted to low-dose metronomic chemotherapy regimens comprising mainly of oral therapies to avoid prolonged stay in the hospital or to limit patient visiting the hospital for intravenous infusions. In this way patients travel to the hospitals and back home were curtailed thus protecting them from the COVID-19 exposure. This was also in line with the lockdown restrictions imposed by the government due to COVID-19 Pandemic. Due to the closure of elective surgeries in pandemic situation, we did not let our cancer patients suffer and resorted to alternate strategies such as changing to chemotherapy or radiotherapy instead of upfront surgery. Later on during the third wave of COVID-19 pandemic when most of our population and hospital staff were vaccinated, limited elective surgeries were allowed those patients who were initially treated by changing the treatment modality were referred for surgeries.

In radiotherapy department we divided our patients into three categories on the basis of priority. Radiotherapy Start (RT-Start) prioritization was based on clinical multidisciplinary meetings through videoconferencing with consultants at other hospitals and decisions based on in-house peer review. About 72.4% of our patients were assigned a delayed radiation start i.e., priority-2 or priority-3. If we look at the statistics of our hospital as shown in the results section (Table: 7 and Figure: 9) most of the patients with breast, head and neck, brain, stomach, esophagus, colorectal, prostate, bronchus and lung cancers were delayed while patients of skin cancer, diffuse Non-Hodgkin's lymphoma, urinary bladder cancers and other connective tissue and soft tissue cancers were assigned early radiation treatment start prioritization (priority-1). We observed that a higher percentage of cases in priority-3 were patients of head and neck, brain, stomach, prostate, bronchus and lung cancers indicating delayed RT-start during COVID-19 in these types of cancers due to their stable nature of the disease while higher percentage of cases in priority-1 or Priority 2 were noted in breast, skin, diffuse Non-Hodgkin's Lymphoma (NHL), other connective tissue soft tissue cancers and urinary bladder cancers indicating early RT-start due to urgency of emergent complications or early stage of the disease.

While delaying radiation treatment, utmost care was taken to avoid potentially deleterious outcomes of delay. Patients' preferences were also taken into consideration while analyzing risk benefit ratio of COVID-19 infection and adverse outcome of delaying radiotherapy. Generally, the types of cancers that were associated with less adverse outcome based on staging and no associated emergent complications were delayed. A few researchers have reported adverse outcome of radiation treatment delays in cancer patients during COVID-19 pandemic.[50] In our study we could not verify any adverse outcome of delaying radiation treatment. This however will require a larger study based on close follow-up of these patients to determine the true impact of prioritization or delayed radiation treatment start (RT-start) on treatment outcome of our cancer patients.

Conclusion:

COVID-19 pandemic brought significant changes in cancer care delivery and likewise cancer hospitals optimized their services to adjust to these changes. Cancer patients due to their inherent immunodeficiency state, has greater vulnerability to COVID-19 infection and this aggravated the challenge further, to radiation oncologists, nuclear physicians and other cancer care providers. Our hospital successfully coped with these challenges to maintain a continuity of cancer care delivery during the pandemic era.

Conflict of Interest:

The authors of this article declare no commercial associations that might pose a potential conflict of interest in connection with the submitted article. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

No writing assistance was utilized in the production of this manuscript.

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